CLAIMS:

1. A valve mechanism for controlling the flow of fluid therethrough, which mechanism comprises a plunger member at least part of which is journalled for axial reciprocation between a rest position and an operative position within an electric coil under the influence of a magnetic field generated by that coil when an electric current passes through the coil, the distal end of the plunger extending into a valve head chamber having an outlet bore in fluid flow communication with a nozzle outlet, the reciprocation of the plunger being adapted to open or close a fluid flow path from the valve head chamber through that bore, characterised in that:
   a. the plunger is of a unitary construction and is made from an electromagnetically soft material having a saturation flux density greater than 1.4 Tesla; and
   c. the plunger has a diameter of 3 mms or less and a length to diameter ratio of less than 15:1.

2. A valve mechanism as claimed in claim 1, characterised in that the plunger is made from a material having a saturation flux density greater than 1.5 Tesla.

3. A valve mechanism as claimed in claim 1, characterised in that the plunger is made from a material having a saturation flux density of from substantially 1.6 to substantially 2.2 Tesla.

4. A valve mechanism as claimed in claim 1, characterised in that the plunger has a diameter of less than 2.5 mms and a length of from 10 to 20 mms.

5. A valve mechanism as claimed in claim 1, characterised in that the plunger has a diameter of less than 1 mm and a length to diameter ratio of from 5:1 to 10:1.

6. A valve mechanism as claimed in claim 1, characterised in that the material from which the plunger is made has a coercivity of less than 100 amperes per metre.

7. A valve mechanism as claimed in claim 1, characterised in that the material from which the plunger is made has a coercivity of less than less than 50 amperes per metre.

8. A valve mechanism as claimed in claim 1, characterised in that the material from which the plunger is made has a relative magnetic permeability in excess of 10,000.

9. A valve mechanism as claimed in claim 1, characterised in that the material from which the plunger is made has a relative magnetic permeability in excess of 50,000.

10. A valve mechanism as claimed in any one of the

preceding claims, characterised in that the nozzle bore leading from the valve head chamber to the nozzle orifice has a length to diameter ratio of less than 8:1.

11. A valve mechanism as claimed in any one of the preceding claims, characterised in that the nozzle bore leading from the valve head chamber to the nozzle orifice has a length to diameter ratio of from 1.5:1 to 5:1.

12. A valve mechanism for controlling the flow of fluid therethrough, which mechanism comprises a plunger member at least part of which is journalled for axial reciprocation between a rest position and an operative position within an electric coil under the influence of a magnetic field generated by that coil when an electric current passes through the coil, the distal end of the plunger extending into a valve head chamber having an outlet bore in fluid flow communication with a nozzle outlet, the reciprocation of the plunger being adapted to open or close a fluid flow path from the valve head chamber to that nozzle orifice through that bore, characterised in that:

b. the plunger is of a unitary construction and is made from an electromagnetically soft material having a saturation flux density greater than 1.4 Teslar, a coercivity of less than 25 ampere per metre, and a relative magnetic permeability in excess of 10,000; and

c. the plunger has a diameter of less than 2.5 mms

and has a length to diameter ratio of from 3:1 to 10:1; and

d. the nozzle bore leading from the valve head chamber to the nozzle orifice has a length to diameter ratio of less than 8:1, and the nozzle orifice has a diameter substantially the same as that of the bore.

13. A valve mechanism as claimed in any one of the preceding claims, characterised in that the bore has a diameter of from 20 to 400 micrometres and a bore length to diameter ratio of from 1.5:1 to 8:1.

14. A valve mechanism as claimed in any one of the preceding claims, characterised in that the plunger has an internal axial bore or cavity formed in the distal end thereof, said bore or cavity extending axially within the plunger proximally no further than that point at which the plunger enters the coil when the plunger is fully retracted into the coil.

15. A valve mechanism as claimed in any one of the preceding claims, characterised in that the nozzle orifice is one of a plurality formed in a nozzle plate carrying an array of a plurality of valves mounted thereon, each nozzle orifice being in register with the plunger of a valve mechanism.

16. An array of valve mechanisms as claimed in claim 15, characterised in that the nozzle bore and the nozzle orifice are formed as a single component with the

nozzle plate.

17. A valve mechanism as claimed in any one of the preceding claims, characterised in that the coil is wound or formed directly upon a tubular support member within which the plunger is to move.

18. A valve mechanism as claimed in any one of the preceding claims, characterised in that the distal wall of the valve head chamber carries one or more upstanding areas to provide an enhanced seal between the opposed end faces of the plunger and the distal wall.

19. A valve mechanism as claimed in claim 18, characterised in that the sealing areas are provided by one or more upstanding ribs substantially concentric with the inlet to the nozzle bore.

20. A valve mechanism as claimed in any one of the preceding claims, characterised in that the coil is a single winding upon a tubular support member.

21. A valve mechanism as claimed in any one of the preceding claims, characterised in that a metal container is provided as a magnetic return path to the coil.

22. An array of valve mechanisms as claimed in claim 16, characterised in that a metal container is provided around each coil to act as a magnetic screen between

adjacent valve mechanisms in the array.

23. A valve mechanism as claimed in any one of the preceding claims, characterised in that the plunger is journalled within a tubular support member for the coil and the plunger and the tubular support member do not have congruent cross sections, whereby axial fluid flow paths are formed between the tubular member and the plunger.

24. A valve mechanism as claimed in any one of the preceding claims, characterised in that the conductor of the coil is deposited, wound or otherwise formed directly upon or within the wall of a tubular support member which provides the interface between the conductor of the coil and the plunger which is journalled in direct sliding engagement within the support member.

25. A valve mechanism as claimed in any one of the preceding claims, characterised in that the nozzle bore has a length to diameter ratio of from 1:1 to 5:1 and a nozzle orifice diameter of from 20 to 400 micrometres.

26. A valve substantially as hereinbefore described with respect to and as shown in any one of the accompanying drawings.

27. A drop on demand ink jet printer in which ink or other fluid is ejected from a nozzle orifice,

characterised in that the flow of fluid from a source of the fluid to the nozzle orifice is regulated by a valve mechanism as claimed in any one of the preceding claims.

28. A drop on demand printer in which a droplet of ink or other fluid is ejected from a nozzle orifice to form a printer dot upon a substrate and in which the flow of the fluid from a source of the fluid to the nozzle orifice is regulated by a valve mechanism comprising a plunger member adapted to be reciprocated within a coil under the influence of an electric current applied to the coil, characterised in that the printer is provided in operative combination therewith with a computer adapted to control the operation of the printer, characterised in that:

a. the computer is adapted to operate in combination with a mechanism for observing the ejected droplet and/or the printed dot of fluid applied to a substrate;

b. the computer is programmed to detect differences between the observed droplet and/or dot and the desired droplet and/or dot and to apply a correction to the current applied to the coil of the valve regulating the flow of fluid to the nozzle orifice so as to maintain the desired observed droplet or dot parameters.

29. A printer as claimed in claim 28, characterised in that the valve is a valve as claimed in any one of claims 1 to 26.

30. A printer as claimed in claim 28, characterised in that the computer is programmed to operate with byte signals.

31. A printer as claimed in claim 28, characterised in that the computer is programmed to respond to the shape and/or size of the ejected droplet and/or the printed dot.

32. A method for operating a printer as claimed in claim 28, characterised in that the performance of the valve mechanism is calibrated using the comparison of the observed and desired parameters for the ejected droplets and/or printed dots so as to provide one or more records of variations to the operation of the valve required to achieve the desired print parameter.

33. A method for calibrating a solenoid valve as claimed in claim 32 using software substantially as hereinbefore described with respect to Figures 9 to 13 of the accompanying drawings.

34. A method for operating a printer as claimed in claim 28, characterised in that the computer modifies the operation of the valve so as to decelerate the plunger at it approaches either or both extreme of its travel.

35. A method for operating a drop on demand printer as

claimed in claim 34 substantially as hereinbefore described with respect to Figures 14 to 16 of the accompanying drawings.

36. A printer or a method for operating it as claimed in any one of claims 28 to 35, characterised in that the desired parameters are stored in one or more look up tables for comparison with the observed parameters.

37. A method for operating the solenoid valve of a drop on demand ink jet printer as claimed in either of claims 27 or 28 to print a line of ink upon a substrate, which line has a length equivalent to at least three individual printed dots, characterised in that the plunger is held in the valve open position by applying a current to the coil of the valve which current has an amplitude of less than 50% of that required to move the plunger initially from its rest position.

38. A method of operating an ink jet printer as claimed in either of claims 27 or 28, characterised in that the valve is operated at a frequency greater than 1 kHz.

39. A method for applying an image forming composition to a pile fabric using a drop on demand ink printer, characterised in that the printer is a drop on demand printer as claimed in either of claims 27 or 28 and in that the printer is operated at a drop generation frequency of at least 1 kHz.

40. A method as claimed in claim 39, characterised in that the pile fabric has a pile length of at least 2 mms and the printer is operated at a pressure of less than 5 Bar.

41. A method as claimed in either of claims 39 or 40, characterised in that the fluid is an ink or dyestuff having a viscosity of from 50 to 150 Cps at 25°C, the fabric is a fabric or textile having a pile length of 1 mms, in that the nozzle orifice has a diameter of from 80 to 250 micrometres and the valve is operated at a frequency of 1 kHz or more.

42. A multi-nozzle drop on demand ink jet print head as claimed in either of claims 27 or 28, characterised in that it comprises a nozzle plate having a plurality of nozzle orifices therein, each at the distal end of a nozzle bore through the nozzle plate, and in that the nozzle plate and nozzle orifices are of a unitary construction and in that each nozzle bore is associated with a valve mechanism for controlling the flow of fluid through that bore.

43. A method for forming the nozzle plate of a print head as claimed in claim 42, characterised in that the nozzle bores are formed substantially simultaneously in the nozzle plate.

44. A print head as claimed in claim 42 or a method as claimed in claim 43, characterised in that the nozzle

orifice and the nozzle bore are formed as a bore within a foil nozzle plate having a thickness of up to 400 micrometres, the bore having a length to diameter ratio of less than 8:1.

45. A valve mechanism for controlling the flow of fluid therethrough and a drop on demand ink jet printer incorporating such a valve mechanism, which mechanism comprises a plunger member at least part of which is journalled for axial reciprocation between a rest position and an operative position within an electric coil under the influence of a magnetic field generated by that coil when an electric current passes through the coil, the distal end of the plunger extending into a valve head chamber having an outlet bore in fluid flow communication with a nozzle outlet, the reciprocation of the plunger being adapted to open or close a fluid flow path from the valve head chamber through that bore, characterised in that:

b. At least a major portion of the plunger is made from an electromagnetically soft material having a saturation flux density greater than 1.6 Tesla; and

d. the plunger has a diameter of 3 mms or less and a length to diameter ratio of less than 15:1.